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[Summary]

The present electronic watch with a solar cell is characterized in that it has a structure in which a solar cell having flexibility is mounted inside the case of the electronic solar cell utilizing the flexibility thereof and a prism is provided under the cover glass to allow light incident on the cover glass to be reflected to the solar cell by the prism.

[Embodiment]

One embodiment of the electronic watch with an amorphous silicon (hereinafter abbreviated as "a-Si") solar cell will be described in detail referring to the drawings.

Fig. 1 is a plan view of the present embodiment, and Fig. 2 is a cross-sectional view of the embodiment shown in Fig. 1, taken along the A-A line.

In Fig. 1, numeral 1 denotes an a-Si solar cell. The solar cell is provided circularly along the outer periphery of the dial and is arranged such that it is opposed to the prism which serves to lead the incident light. In Fig. 2, the a-Si solar cell 1 is formed on a stainless steel base substrate. The light which transmits the cover glass 8 is refracted by a prism 2 arranged circularly, and reaches the a-Si solar cell 1. The stainless steel base substrate 9 is crimped to a case 4 utilizing the elastic stress thereof. The output of the a-Si solar cell is connected from an electrode 7 to a circuit block 6 by a lead terminal 10.

This prism is not necessary be formed integrally with

the cover glass. As shown in Fig. 3, the prism may be provided separately on a dial 3 as a ring-like prism (2'). In this case, the angle of the prism can be changed readily to ensure a high degree of freedom in design and efficiency.

Fig. 4 shows the a-Si solar cell provided on the stainless steel base substrate. Numeral 1 denotes the a-Si solar cell, numeral 9 denotes the stainless steel base substrate, and numeral 7 denotes the electrode. A smaller width (w) of the electrode is advantageous for cost reduction.

[Advantageous effects]

As mentioned above, in the present device, by providing the prism under the cover glass, the solar cell can be mounted inside the case body. By changing the prism angle, the area of the solar cell appearing on the display can be changed freely, which results in diversified designs. By restricting the size of the prism to be the same or smaller than the width of the solar cell, the electrode can be provided on the surface of the solar cell base substrate. In addition, the solar cell can be connected to the circuit block at any position, which enhances the degree of freedom in design. Further, adhesion of the solar cell to the inside of the case body utilizing its own flexibility eliminates the need of fixation means, leading to effective cost reduction. Since the electrode is provided below the dial, all of the visible parts can be utilized to obtain photoenergy of the solar cell, whereby an efficient solar cell can be obtained for the same area. The present device can be applied to other electronic devices utilizing a

solar cell, such as electronic calculators.

One embodiment of the present invention is shown in Figs. 3 to 9. In the figures, numeral 10 denotes a front case, which is provided in front of a rear case 11. A movement 12 is engaged with a circular movement engagement wall 13 which is provided in the middle of the rear case 11. Numeral 14 denotes a dial, numeral 16a denotes a minute hand, and numeral 16b denotes an hour hand. The dial 14 is covered by a transparent front cover 15 which is engaged with the inner peripheral hole of the front case 10. The front case 15 is made of a glass plate or the like. The outer periphery of the dial 14 is surrounded by a solar cell 17. The solar cell 17 is provided such that it is arranged perpendicularly to the dial 14 and the light-receiving surface thereof is directed inwardly.

Numeral 22 denotes a ring-like prism. The outer peripheral face thereof is opposed to the light-receiving surface of the solar cell 17, and interposed between the back surface of the front cover 15 and the dial 14. The ring-like prism 22 has an inverted trapezoidal cross section in which an inner peripheral face 22a is inclined with an inclination angle α of about 45°. The ring-like prism 22 is made of a transparent acrylic or the like.

The solar cell 17 is fixed to a strip-like flexible printed circuit board 18. The printed circuit board 18 is pressed from upward by the front case 15 with its lower part being inserted into a circular groove 20 which is provided in the inner periphery of a circular supporting wall 19 of the rear case 11. Fig. 7 shows a pattern 18a of

the flexible printed circuit board 18. Fig 8 shows a state in which the pattern 18a is provided with the solar cell 17. Four solar cells 17 are connected in parallel by a cable 21 and the pattern 18a, thereby to provide a single set of the solar cells. Six sets are then connected in series. That means that the six sets each having an area four times larger than the area of the individual solar cell 17 are connected in series. The solar cell 17 is directly connected to a drive motor inside the movement 17, or is connected to a secondary battery which drives the motor.

As mentioned above, since the solar cell 17 is provided perpendicularly and the ring-like prism 22 is provided on the back surface of the front cover 15, the light entering the ring-like prism 22 from the top of the front cover 15 then enters the light-receiving surface of the solar cell 17. The surface electrode of the solar cell 17, the cable, the pattern 18a of the printed circuit board 18 and the like are not visible from outside, since the solar cell 17 is positioned perpendicularly to the dial 14 and the lower part of the solar cell 17 is positioned lower than the dial 14. The solar cell 17 is only visible from the front through the ring-like prism 22, as shown in Fig. 3. In addition, the rectangular solar cells 17 are seen as fan-shaped solar cells, and gaps between adjacent solar cells appear to be arranged in parallel. Therefore, as compared with the conventional electronic watch with a solar cell in which the solar cells are arranged in parallel, the electronic watch with a solar cell according to the present device is excellent in appearance. In addition, since the ring-like prism 22 and the front cover

15 are configured as separate components, it is possible to use a simple glass plate for the front cover 15. Further, the ring-like prism 22 can be readily produced as compared with conventional techniques in which a ring-like prism portion is integrally formed on the periphery of a plate-like portion.

[Advantageous effects of the device]

The present electronic watch with a solar cell has advantageous effects that it can concentrate light efficiently without impairing the appearance of the watch, and it can be produced readily.

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p1

3. Detailed Description of the Device

The present device relates to an electronic watch in which a solar cell is formed on the surface of the glass panel of a liquid crystal panel as a dial trim of the liquid crystal panel.

p3

In Fig. 2, numeral 16 denotes a liquid crystal panel, and numeral 166 denotes an upper glass panel. Numeral 12 denotes a thin film solar cell. Liquid crystal display is performed outside the region where the thin film solar cell is formed.

p4

The liquid crystal panel 16 on which the thin film solar cell is formed is fixed by a panel frame 21 and a movement substrate 18. For fixation, the same method as used in the conventional portable watch provided with a liquid crystal panel can be used. The fixation part can be concealed readily by an internal printing 14. The same effect can be attained by using a dial trim plate instead of the internal printing.